
LDAP:

A Data Acquisition Program Written Using LabVIEW

Thomas A. Spencer

March 1997

Interim Report

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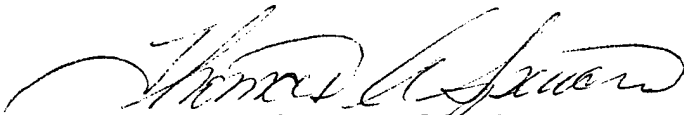
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14. Abstract This report describes how to use LDAP (LabVIEW Data Acquisition Program), a data acquisition system written to take single shot pulse power/radio frequency data. The report describes how LDAP expects inputs, how LDAP communicates with scopes, how LDAP arrives at the data it plots, and LDAP's ability to call and communicate with other applications. LDAP gives one the ability to: setup digitizing scopes (analyzers); input and save information about different probes (such as Rogowski coils, B-DOTs, magnetic field conversions, etc.), cable calibrations, crystal diode calibrations; give titles to individual channels; save comments; acquire and display data; setup and control DG535s, HP16531, HP16532 digitizing cards (in an HP16500), HP54111D digitizing scopes, TEK TDS210, TEK TDS420, TEK TDS544A, TEK DSA602(A), and TEK TDS744A digitizing scopes.					
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1. Background

A need was acknowledged that perhaps it was time to move on from a quite useful and excellently written data acquisition package written by Dr. M. Collins Clark using the ASYST [1] language. The program, called DAC (Data ACquisition), enables a user to setup HP54111D and HP16500 Digitizers (HP16531 400 megasample digitizing cards, with the appropriate time card), acquire data, store it, plot it as real data (by using stored calibration information for crystal diodes, probes, and attenuation coefficients), and analyze it with DAR (Data Analysis Routines) procedures, including user written procedures. It has several eccentricities (not unlike the programmer), and was originally written on and for a 286 class machine. DAC is still presently in use (and has been since about 1987). But it only runs on 286 class machines. Attempts at running it on a higher processor machine have failed, mainly in trying to get the graphics to display to a higher graphics resolution monitor. Also, the 'lock disks' required to run ASYST require a 5 1/4 inch disk, formatted at 360k, which there seems to be less of a call for these days. And, perhaps most detrimental of all, there is no manual describing DAC in any detail, gory or otherwise.

LabVIEW [2] was chosen to be used as the 'program of choice' to update the ASYST capabilities to 486 and Pentium machines (and for the future Pentium Pro machines). The reasons LabVIEW was chosen was its graphical user interface, relative ease of programming, built in GPIB (General Purpose Interface Board) routines, and cross-platform compatibility. That is, versions of LabVIEW exist for Unix based workstations (such as the Sun Machines), IBM PC and compatibles, and Macintoshes (both 680x0 and PowerPC) and are easily ported from one platform to another. Disadvantages of using LabVIEW include its high memory overhead and some speed loss due to the graphical nature of the all the modules. Thus LabVIEW was chosen to write a program called LabVIEW Data Acquisition Program (LDAP) to do the digitizing of scopes, acquiring and storing of data from the scopes, to provide a basic plotting program, and include routines for making probe calibration files, crystal diode calibration files, and channel information files (containing such information as channel number, scope type, attenuation coefficients, volts/div, timescale, etc.). This enables the user to setup, get, view, and print data much quicker than the 'speeding 286' DAC routines. This manual describes the options and routines for LDAP.

Most of the items in each of the menu layouts are based on DAC, done in order to reduce the learning curve from those who were already familiar with the DAC system. Note that the button labels listed throughout this manual might be slightly changed from what is actually displayed in the program. Also note that the author uses the assumption that the user(s) are familiar with the digitizing oscilloscopes/analyzers and the digital delay generator referenced throughout this manual.

2. System Requirements

LDAP can be run on most systems on which LabVIEW can be run. However, it is recommended that you have at least 32 MB of RAM, and that you have a Pentium or PowerPC class machine. LDAP will run under Windows 3.1, Windows95, and MacOS, operating systems, and on a 486 class machine, or a 68020 or better class machine (Macintosh). LDAP should run on any Unix class machine, although as of this writing it has not been tested on a Unix machine. The difference in speed between a 486 and a Pentium class machine in both loading and running LDAP is remarkable. Five minutes or

so to load LDAP on a 50 MHz 486 machine is reduced to just ten to fifteen seconds on a 133 MHz Pentium machine.

3. LDAP Use and Features

LDAP gives one the ability to: setup digitizing scopes (analyzers); input and save information about different probes (such as Rogowski Coil calibration, B-Dot probes, magnetic field conversions, etc.), cable calibrations (both attenuations and time delays), crystal diode calibrations (of polynomial degrees up to order five); give titles to individual channels; make comments about the individual channels; make comments about each shot; acquire data and display the data; as well as many other features. These features will be described below, along with the general layout of LDAP.

LDAP can be started in several ways. For Windows95, double click on the 'BeginWithMe' shortcut on the desktop. LabVIEW will start and open up a library which contains the 'BeginWithMe.vi'. Double click on this VI, and LabVIEW loads all the modules associated with LDAP. As of this writing, there are approximately 130 modules, some of which are provided by LabVIEW and National Instruments. Another way is to open the 'BeginWithMe.vi' located in the 'WorkOut.llb' library, stored in the directory 'MyLabVis.dir' within the 'LabVIEW' directory (Mac or PC).

After LDAP has finished loading, it will prompt for a setup file, listing only those files of the expected setup file format (see Appendix B for expected file formats). The setup file contains information on the following: channel directory, shot directory, channel file listing, default shot number, and the setup number. Once the setup file is loaded, LDAP checks the directory where the setup file is located for a parameters file, a probe file, a cable file, and a crystal file. If none, or more than one, of these types of files are found in the directory, LDAP will prompt you for more information, such as which file to use, or if none are found, if you would like to create one of the proper format. The parameters file is the base file that contains editable comments about the previous shot. The probe file contains titles, values, and units of the probe calibrations (Voltage Monitors, Rogowski Coils, etc.). The cables file contains one-way time delays (in secs) of the cable calibrations. The crystal file contains the titles, polynomial coefficients, and degree of polynomial for each crystal diode calibration.

When LDAP has finished loading the expected files, LDAP then performs a quick check on the channels directory stored in the setup file. If the number of channel files saved in the setup file is different than the actual number in the channel directory, LDAP alerts the user to this fact, but does nothing on its own to correct it. This correction is left to the user. A non-editable window is then displayed (see Figure 3.1) showing some of the setup file information (such as channel directory, shot directory, default shot number, whether 'AutoPlot' is toggled 'On' or 'off', etc.), and the main menu of the program appears. Note that turning on the Help Window (ctrl-H) may be of use for novice users of LDAP, since many of the menu choices have associated descriptions that are displayed in the Help window when the pointer passes over them.

Setup#	Setup File Name
1	testsetup.1
Present Channel Directory	
Applications:Lab View 4.0: TestSetupMake.dir:testchannels.dir	
Present Shot Directory	
Applications:Lab View 4.0: TestSetupMake.dir:testshots.dir	
Default Shot Number	AutoPlot Status
0	OFF
Computer Trigger	
Disabled	

Figure 3.1. Example of the setup information displayed in the 'DisplayData' window.

At present, LDAP works on a single shot basis with the following equipment: the DG535 Digital Delay Generator (available from Stanford Research Systems, Inc. [3]); the Tektronix TDS 544A (or any TDS 540 series) digitizing scope [4]; the HP16531, an Hewlett-Packard 400 megasample digitizing card (in an HP16500 mainframe) [5,6]; the HP16532, an Hewlett-Packard one gigasample digitizing card (in an HP16500 mainframe) [7]; and the Hewlett-Packard HP54111D Digitizing Oscilloscope [8]. Presently, the Tektronix DSA602 is being added to the system, and the author intends to add the TEK TDS720, TEK TDS420 series, as well as the TEK 2440 and 2430 series of scopes, but does not yet have a schedule to complete these tasks.

The following section describes, in a top down fashion (and unavoidably dry), the menu choices available and what the LDAP program does when these various items are selected.

3.1 The Main Menu

The main menu is a set of the following named buttons: 'Shot Menu', 'Channel Menu', 'DG535 Menu', 'Utilities Menu', 'Save Setup', 'Recall Setup', 'Change Channel Directory', 'Configuration', 'DAR', 'General Info', and 'Exit'. See Figure 3.2.

3.2 The Shot Menu

The 'Shot Menu' button calls up the 'Shot Menu' which contains the following set of buttons: 'Fire Shot', 'Directory', 'Change Shot Drive', 'Plot Shot', 'Set Plot Range', 'Edit Parameters', 'View Parameters', 'Program Channels', 'Edit Shot', 'Utility', 'Shot Delay', and 'Return'. See Figure 3.3.

3.2.1 Fire Shot

The 'Fire Shot' button arms the digitizers, creates pertinent shot information files (such as SHOTxxxx.CHN, SHOTxxxx.VAL, and SHOTxxxx.TIM, where 'xxxx' is the shot number), and then opens a window where the user can update the parameter comments, the shot number, and proceed (or cancel) the shot (see Figure 3.4). Appendix B explains what the above mentioned files consist of. The routine also creates an individual directory for each shot taken (named SHOTxxxx.dir) and stores individual channel data acquired from the scope in this directory. The other files mentioned above are also stored in the SHOTxxxx.dir directory. After arming the digitizers, a screen displays the 'Waiting For Trigger' statement. If the 'Disable/Enable' boolean for the DG535 has been set to enable (see §3.10), then the button for sending a single shot command to a DG535 is displayed, enabling the user to single trigger the DG535 (see Figure 3.5). The routine then waits until the first digitizer has received a trigger, and then downloads the data from all the digitizers and saves the data to disk. If the 'AutoPlot' boolean (discussed under the 'Main Menu:Configuration' submenu) has been set to 'On', then the routine automatically plots the acquired data to the screen, either using the LDAP plotting routine or the DARIDLR routine [9]. This depends on which routine has been chosen in the 'Main Menu:Configuration:Routine to Plot' submenu. Before the data is plotted, the parameters and hookup of the shot will be displayed. These can be printed by choosing the 'Print' option from the 'File' menu. Note that setting the 'Print Setup' to 'Landscape' makes the output easier to read.

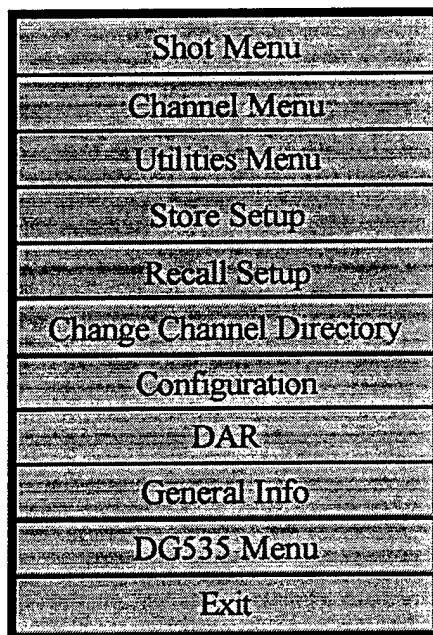


Figure 3.2. The Main Menu options.

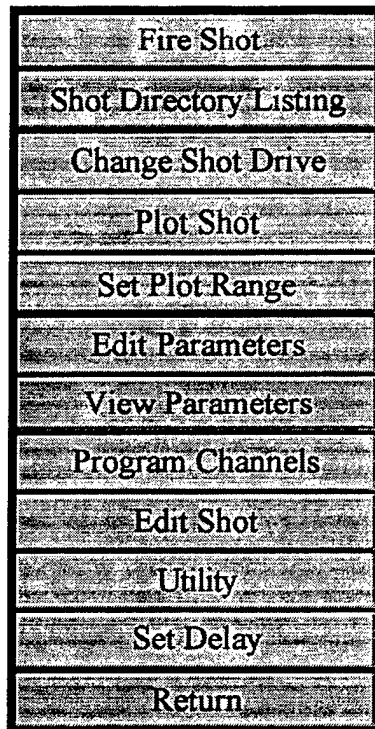


Figure 3.3. The Shot Menu options.

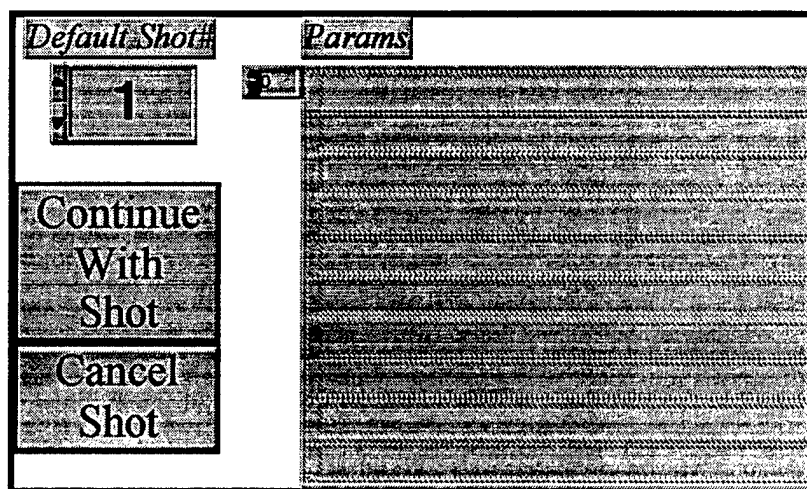


Figure 3.4. The 'Fire Shot' layout.



Figure 3.5. The layout for sending a single shot trigger to the DG535.

3.2.2 Shot Number Directory

This displays the shot directories of the type SHOTxxxx.Dir stored in the 'Shot Directory Path' in the present setup file. Only the shot number itself is displayed in the window (for example, 651, not SHOT651.Dir).

3.2.3 Change Shot Directory

Allows the user to re-direct where the acquired shot data will be stored. This also updates the present setup file. Note that for Windows95 and MacOS users, you can create a new directory when the standard save file resource manager is called (built into LabVIEW), without first having to go to the desktop and created a new shot directory. This menu choice is also available in the 'Main Menu:Utilites Menu' submenu.

3.2.4 Plot Shot

Prompts the user whether or not to plot the previous shot data acquired, or some other previously acquired data (either DAC [ASYST] Format or LDAP format). Note that at the present time, the 'Plot Previous Shot' option only works after data has been taken while running the present session. That is, if you load LDAP and choose the 'Plot Previous Shot' option, the routine may not work correctly. The author is presently working on fixing this previously 'undocumented feature' of the program.

When the plot window is displayed, four plots are shown. At the upper left of the window, the shot number, and date and time the shot was recorded are displayed. The channel title is displayed immediately above each plot. The upper right of the window shows the total number of channels to be plotted. Several features are available for changing the view of the acquired data (See Figure 3.6). One of the features is the standard cursor and zoom fields provided by LabVIEW. These are located immediately below each plot. The cursor values displayed are the actual maximum and minimum values from the plot itself (an easy way to quickly see the peak RF power, for example). Zooming in is done by using the 'magnifying glass' (which gives the user options of how to zoom in; just x-axis; just y-axis; both; etc.). Use the 'hand' tool to reposition the data within the plot window. Immediately to the right of each cursor field grouping, there is an export button. This is used for exporting data to a file in an ASCII, tab-delimited format. Only the data

displayed in the window is actually exported (thus if you zoom in to an interesting portion of the data, only that data is exported). The exported data are the final calculated values shown (not the 'raw' data), and are exported as x-y pairs. No header information is exported, only the numbers themselves. Another feature added is the 'Set Plot Range' button located at the top center of the window, to enable the user to reset the timebase plot range. Note that this does not take effect until the next set of channel data is plotted.

After plotting the four data channels, a 'Press Me To View The Next Plots' button appears in the lower left of the window, which is pressed to view the next set of plots. After all plots have been displayed, the 'Press Me To Return To Shot Menu' button appears in the lower right of the window. Note that at the present time, there is no cancel routine to exit out of the LDAP plotting routine. Thus you must view all the plots before returning to the 'Shot Menu' options. The cancel routine will probably be added in a future version.

3.2.5 Set Plot Range

Allows the user to select a plot range that displays all the data shots within the chosen minimum and maximum 'x' range. However, if there are not enough data points within the plot range for a particular data channel, the program will display the whole trace for that channel data. This may occur if one of the channels was taken on a much larger time scale (such as magnetic field data, which is typically taken on a microsecond or millisecond time scale, as opposed to most RF or Pulsed Power data which may be taken on a couple of hundred nanoseconds time scale). This menu choice is also available under the 'Main Menu:Configuration' submenu.

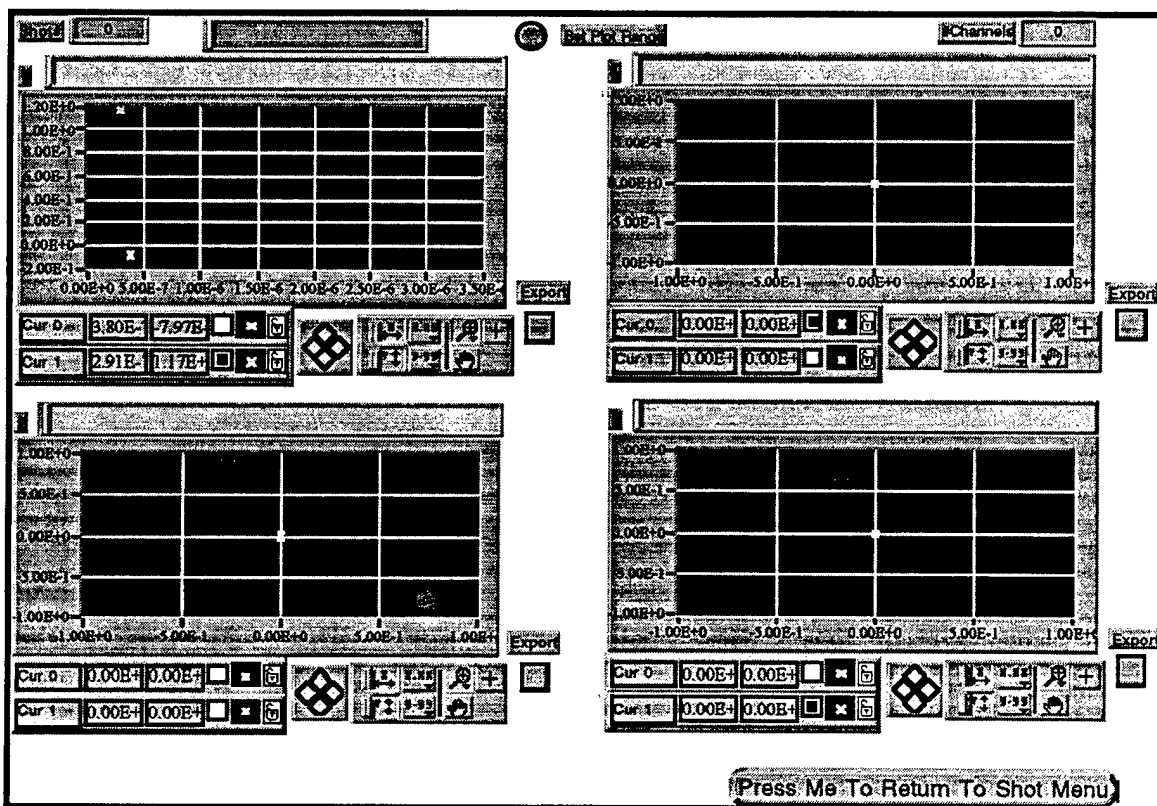


Figure 3.6. An example of the LDAP plot layout.

3.2.6 Edit Parameters

Allows the user to edit the parameters (comments) for each given shot. Note that the parameters are stored as a string array, so editing the parameters is done by editing the array. Use the 'Up/Down' arrow to index the element of the string array to change. Note that the parameters file is updated by the 'Edit Shot' menu item, by storing the previous shot parameters before they are edited (see the 'Edit Shot' Section, § 3.2.9). Figure 3.7 has an example of the layout.

3.2.7 View Parameters

Allows the user to view the parameters (comments) for each given shot. Note that the parameters are stored as a string array, so viewing the parameters is done by viewing the array. Use the 'Up/Down' arrow to index the element of the string array to view.

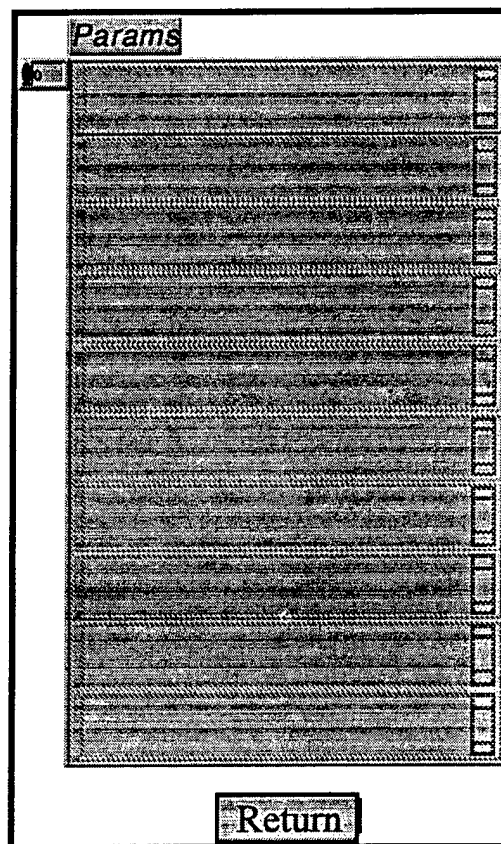


Figure 3.7. Example of the 'Edit/View Parameters' layout.

3.2.8 Program Channels

Sends the setup commands of the 'On' channels to the digitizers. This allows the user to see the digitizer configurations displayed on each digitizer before actually performing a 'Fire Shot' routine. Note that this should always be done before actually going through the 'Fire Shot' routine. This minimizes possible lock-ups that may occur due to peculiarities of individual digitizer firmware that might cause loss of data during an actual data acquisition process. This menu item is also available in the 'Main Menu:Channel Menu' submenu.

3.2.9 Edit Shot

The 'Edit Shot' routine allows the user to update a previously acquired and stored data channel file which may have contained errant values of one sort or another. First, the user is prompted to choose an individual shot directory which contains the previously acquired and stored data. The user is then prompted to choose from a list of stored channel data files, or to view the present parameters file stored within the given shot directory (see Figure 3.8). As an example, suppose the cable attenuation was actually 40.2 dB instead of 0.0 dB. By using the 'Edit Shot' routine, you can easily change this, and then re-plot the shot. Also, the original settings of the shot file are stored in the SHOTxxxx.PRM file, so a record of all edited changes can be viewed, in case there really was no error. At present, the 'Edit Shot' ability is only available to LDAP formatted data files, not ASYST formatted files.

The parameters that may be edited are the data title, the data comments, the data fixed/cable/other attenuations, the integrator value, the probe position, the probe number, the cable number, and the crystal number. See Figure 3.9 for an example of the displayed window. Note in the figure that the user may edit those parameters listed on the left. Press 'Update This Page' to display the new values in the fields on the right, and to update the values to the file when 'Return' is pressed.

3.2.10 Utility

This menu item is 'Grayed Out' and will probably be removed in future versions. Added here because it was an original choice in DAC. It is not used by LDAP. Most of the available DAC choices are available in the DARIDLR program [9].

3.2.11 Shot Delay

This menu item is 'Grayed Out' and will probably be removed in future versions. Added here because it was an original choice in DAC. It is not used by LDAP. Set the shot delay of each scope in the 'Main Menu:Channel Menu:Configuration' submenu.

3.2.12 Return

Returns to the Main Menu.

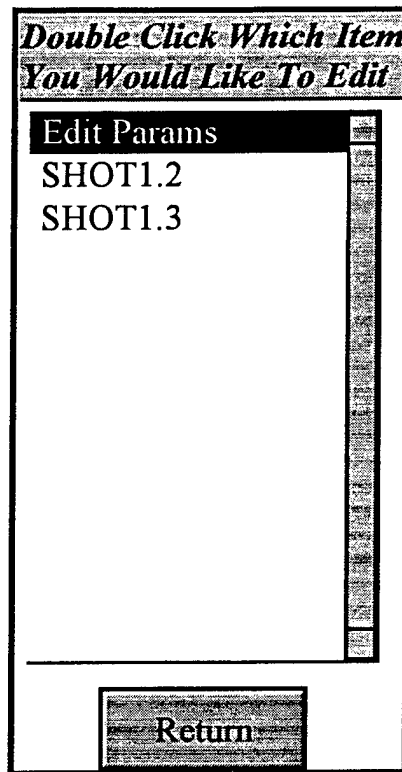


Figure 3.8. The window layout for choosing a previously acquired data channel to edit.

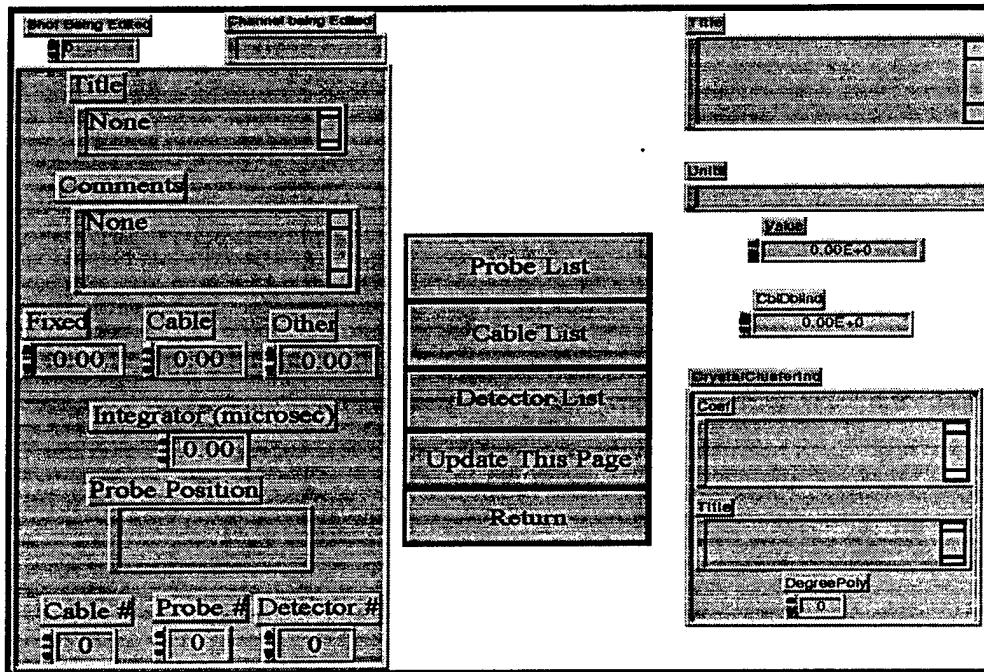


Figure 3.9. Layout of the actual parameters that the user can edit for a previously acquired channel data. Note that one may edit those parameters listed on the left. Press 'Update This Page' to display the new values in the fields on the right.

3.3 Channel Menu

This menu selection provides access to the channel manipulation routines. These consist of the 'Configure Channel', 'Channel Directory', 'Initialize', 'Turn On/Off', 'Show Hookup', 'Program Channels', and 'HP54 Colors' menu items. These are described in more detail below. See Figure 3.10.

3.3.1 Configure Channel

This is the heart of LDAP for programming the digitizer configurations, attenuation choices, and probe/cable/crystal selections. First, the user is prompted to select a channel description file to configure (the choices are those channels found in the present channel directory), and the choice can be made by either highlighting a list item and pressing the select button or by double-clicking the list item (see Figure 3.11). Next, a window containing all the pertinent information choices is displayed, where the user can choose from many different options (see Figure 3.12).

The user can set: the type of digitizer (scope) to be configured from a menu ring (HP54111D | HP16531 | HP16532 | Tek TDS544A); the channel status (Off | On) by pressing the boolean button; the GPIB information (both the bus and address of the digitizer) by typing in a numerical value, or by clicking the up/down arrows; the digitizer channel number (range is from one to ten) by typing a value, or by clicking the up/down arrows; the volts/div by typing in the value (real) or using the up/down arrows, and then choosing the units (mV | V) from the menu ring immediately to the right of the numerical value; the offset (number of divisions, not an absolute voltage value!) by typing in a value, or using the up/down arrows; the coupling of the channel, by choosing from a menu ring (DC 1 M Ω | DC 50 Ω | AC | GND); a title for the channel; attenuation information, be it 'Fixed', 'Cable', or 'Other', by typing in a value, or using the up/down arrows; an integrator value (in microseconds), by typing in a value, or using the up/down arrows; the probe number, cable number, or crystal detector number, by typing in a value, or using the up/down arrows; the probe position (input as text); comments (input as text); the timebase/trigger mode (boolean, Triggered | Auto); the sweep range (timebase) and sweep delay, by typing in the value (real) or using the up/down arrows, and then choosing the units (picoseconds | nanoseconds | microseconds | milliseconds | seconds) from the menu ring immediately to the right of the numerical value; the trigger level, by typing in a value, or using the up/down arrows (must be a real value, and in Volts); the trigger slope (boolean, Positive | Negative); the trigger mode from a menu ring (Edge | Pattern | Other); the trigger source from a menu ring (External | Channel 1 - Channel 10). Note 'Edge' is the only trigger mode implemented in LDAP at this time.

Also available in the window are three buttons located to the right of the window, 'Probe List', 'Cable List', and 'Detector List', which allows the user to quickly obtain the number necessary to fill the probe, cable, and crystal detector fields.

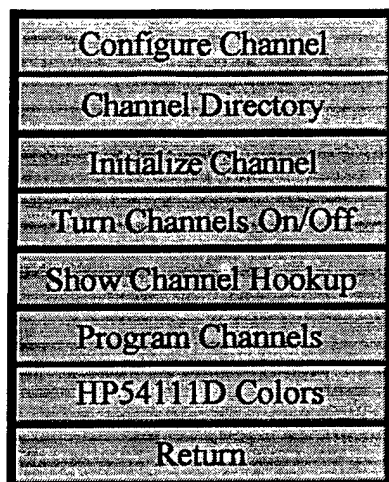


Figure 3.10. The 'Channel Menu' options.

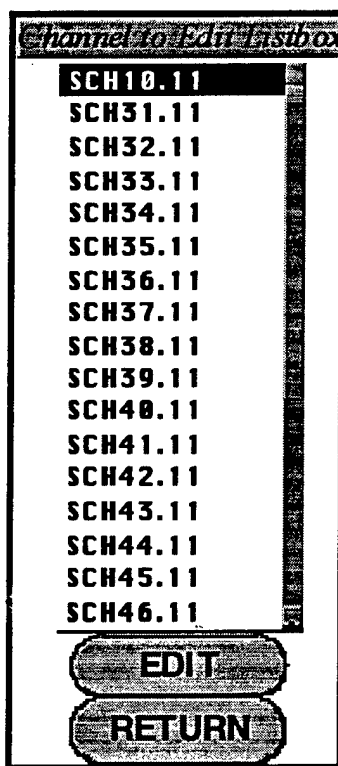


Figure 3.11. Example of the 'Channel to Edit' layout.

3.3.2 Channel Directory

This routine displays the current channels found in the present channel directory.

3.3.3 Initialize

This routine allows the user to create (initialize) a channel description file by prompting for a setup number associate the channel and a channel number for storing the file (see Figure 3.13). The routine then calls the 'Configure Channel' routine, where the user can then configure the channel (refer to §3.3.1).

Channel Number: 0

Scope Type: HP 54111D

Status: OFF

BPIB Info

GPiB Address: 0

GPiB Bus: 0

Scope Channel Number: 1

Attenuation Info

Fixed: 0.00 Cable: 0.00 Other: 0.00

Integrator (microsec): 0.00

Probe #: 0

Probe Position:

Cable #:

Detector #:

Data Increment: 1X

Comments: None

Timebase Info

Timebase Mode: Triggered

Sweep Range: 0.00 nanosec

Sweep Delay: 0.00 nanosec

Trigger Info

Trigger Level: 0.00 Volts Slope: Positive

Trigger Mode: Edge

Trigger Source: External

Probe List

Cable List

Detector List

RETURN

Figure 3.12. The options layout for configuring a channel.

<i>Channel To INITIALIZE</i>	
<input type="text" value="1"/>	
<i>Part OF SAVED SET #</i>	
<input type="text" value="1"/>	
<input type="button" value="Initialize"/> <input type="button" value="RETURN"/>	

Figure 3.13. Example of the 'Initialize Channel' layout.

3.3.4 Turn On/Off

This routine provides an easy way for the user to turn a given channel configuration 'On' or 'Off'. The window displays two columns of information (see Figure 3.14). The left column displays the channels presently 'On', while the right column displays those presently 'Off'. By highlighting any of the selections (to select multiple list items, hold down the <shift> key while clicking on an item) in either of the columns, the routine will automatically move the selected channels from one column to the other. This is much faster than the more tedious process of using the 'Configure Channel' routine, and setting the 'On/Off' status button for each channel.

3.3.5 Show Channel Settings (Show Hookup)

This routine displays the present channel configuration for the channels that have a status of 'On'. See Figure 3.15 for an example of the information that is displayed.

3.3.6 Program Channels

Sends the setup commands of the 'On' channels to the digitizers. This allows the user to see the digitizer configurations displayed on each digitizer before actually performing a 'Fire Shot' routine. Note that this should always be done before actually going through the 'Fire Shot' routine. This minimizes possible lock-ups that may occur due to peculiarities of individual digitizer firmware that might cause loss of data during an actual data acquisition process. This menu item is also available in the 'Main Menu:Shot Menu' submenu.

Channels Presently ON		Channels Presently OFF	
Sch11.4	<input type="checkbox"/>	Sch1.4	<input type="checkbox"/>
Sch12.4	<input type="checkbox"/>	Sch2.4	<input type="checkbox"/>
	<input type="checkbox"/>	Sch3.4	<input type="checkbox"/>
	<input type="checkbox"/>	Sch6.4	<input type="checkbox"/>
	<input type="checkbox"/>	Sch13.4	<input type="checkbox"/>
	<input type="checkbox"/>	Sch14.4	<input type="checkbox"/>
	<input type="checkbox"/>	Sch15.4	<input type="checkbox"/>
	<input type="checkbox"/>	Sch16.4	<input type="checkbox"/>
	<input type="checkbox"/>	Sch17.4	<input type="checkbox"/>
	<input type="checkbox"/>	Sch18.4	<input type="checkbox"/>
	<input type="checkbox"/>	Sch19.4	<input type="checkbox"/>
	<input type="checkbox"/>	Sch20.4	<input type="checkbox"/>

Select

Return

Figure 3.14. Example of the 'Turn On/Off' layout.

Shot Number		0	2/18/97	12:49 PM										
Ch	St	CB	CBns	Title	FIXdB	CABdB	OTHdB	RCus	XL	T/D	DLY	V/D	PB	Scale Units
1	On	0	-----		0.0	0.0	0.0	0.0	0	Ops	Ops	0mV	0	1.00E0 Volts

Figure 3.15. Example of the displayed parameters in the 'Show Hookup' routine.

3.3.7 HP54 Colors

This menu item is 'Grayed Out' and will probably be removed in future versions. Added here because it was an original choice in DAC. It is not used by LDAP.

3.3.8 Return

Returns to the Main Menu.

3.4 Utilities Menu

This item allows access several utility routines. They consist of 'HP54111D Prog', 'Change Channel Directory', 'Change Shot Directory', 'Probes', 'Cables', 'Crystals', 'Make Single Shot Directories', and 'Make Time Stamp'. See Figure 3.16. These are described in more detail below.

3.4.1 HP54111D Prog

This menu item is 'Grayed Out' and will probably be removed in future versions. Added here because it was an original choice in DAC. It is not used by LDAP.

3.4.2 Change Channel Directory

Allows the user to change which channel directory to use as the channel configuration files. This routine automatically updates the setup file. Note that for Windows95 and MacOS users, you can create a new directory when the standard save file resource manager is called (built into LabVIEW), without first having to go to the desktop and created a new shot directory. This menu choice is also available in the 'Main Menu' submenu (as it is in the original DAC program).

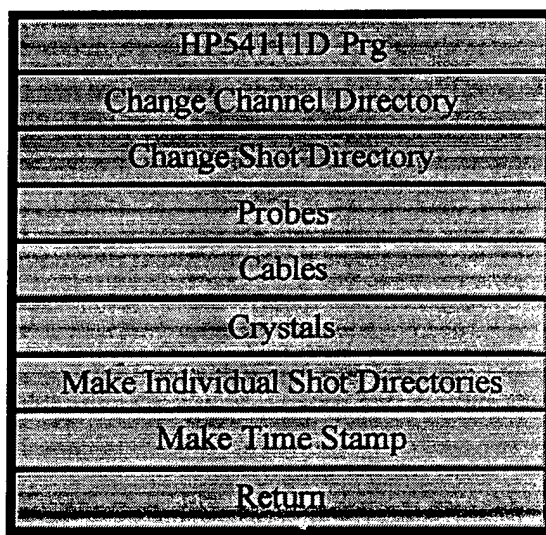


Figure 3.16. The 'Utilities Menu' options.

3.4.3 Change Shot Directory

Allows the user to re-direct where the acquired shot data will be stored. This also updates the present setup file. Note that for Windows95 and MacOS users, you can create a new directory when the standard save file resource manager is called (built into LabVIEW), without first having to go to the desktop and created a new shot directory. This menu choice is also available in the 'Main Menu:Fire Shot Menu' submenu.

3.4.4 Probes

This item selection pulls up the 'Probes Submenu' selections, consisting of 'Edit', 'Directory', 'Make New Probe File', and 'Change Probe File'.

3.4.4.1 Edit

This routine allows you to add a new probe (title, unit, and value) or edit a previously created probe to be available to the 'Configure Channel' routine. See Figure 3.17 for an example of the probe listings. There is no limit to the number of probes that can be stored in the probe file, as opposed to the 50 limitation of the DAC system.

Probe	Name	Value	Units
Add New Probe			
1	Upstream Rogowski	5.33E+9	None
2	Downstream Rogowski	4.46E+9	Amps
3	Magnetic Field	4.40E-1	kGauss
4	Upstream Rog 2	9.70E+4	None
5	Downstream Rog 2	1.09E+5	None
6	New Probe	1.00E+1	Funny Units
7	Another New Probe	1.00E+0	SHU

Select
Return

Figure 3.17. Example of the 'Edit Probe' window.

3.4.4.2 Directory

This routine displays the different probes stored in the present probe file. The displayed parameters are the probe number, title, value, and units (the units are what are displayed as the y-axis in the DARIDLR program).

3.4.4.3 Make New Probe File

This routine allows the user to make a new probe file of the correct format, either empty or to just rename and move the present probe file to another directory (useful when creating new setups).

3.4.4.4 Change Probe File

This routine allows the user to change the probe file presently being used by LDAP. Note that this does *not* update the setup file, since this information is initially loaded from the directory that the setup file is stored in, not in the setup file itself. This may be changed in future versions, to include the probe file as part of the overall setup file.

3.4.4.5 Return

Returns to the Utilities Menu.

3.4.5 Cables

This item selection pulls up the 'Cables Submenu' selections, consisting of 'Edit', 'Directory', 'Make New Cable File', and 'Change Cable File'.

3.4.5.1 Edit

This routine allows you to add a new cable (the value, in seconds, of the one-way delay time associated with the cable) or edit a previously created cable to be available to the 'Configure Channel' routine. See Figure 3.18 for an example of the cable listing. The display defaults to nanoseconds (ns) when showing the delay time. There is no limit to the number of cables that can be stored in the cable file, as opposed to the 50 limitation of the DAC system.

<i>Cable #</i>	<i>Delay (ns)</i>
Add New Cable	
1	0.00 ns
2	0.00 ns
3	200.00 ns
4	100.00 ns
5	25.00 ns
6	20.00 ns
7	190.00 ns
<div>Select</div> <div>Return</div>	

Figure 3.18. Example of the 'Edit Cable' window.

3.4.5.2 Directory

This routine displays the different cable one-way delay values (in nanoseconds) stored in the present cable file. The displayed parameters are the cable number and one-way delay value. Future versions of LDAP may allow a title to be associated with the cable number.

3.4.5.3 Make New Cable File

This routine allows the user to make a new cable file of the correct format, either empty or to just rename and move the present cable file to another directory (useful when creating new setups).

3.4.5.4 Change Cable File

This routine allows the user to change the cable file presently being used by LDAP. Note that this does *not* update the setup file, since this information is initially loaded from the directory that the setup file is stored in, not in the setup file itself. This may be changed in future versions, to include the cable file as part of the overall setup file.

3.4.5.5 Return

Returns to the Utilities Menu.

3.4.6 Crystals

This item selection pulls up the 'Crystal Menu' selections, consisting of 'Edit', 'Directory', 'Check Crystal Cal', 'Make New Crystal File', and 'Change Crystal File'. See Figure 3.19.

3.4.6.1 Edit

This routine allows you to add a new crystal diode configuration (up to six polynomial coefficients, and the order of the polynomial of range two to five, plus a title) or edit a previously created crystal to be available to the 'Configure Channel' routine. See Figure 3.20 for an example of the crystal edit field layout. There is no limit to the number of crystals that can be stored in the crystal file, as opposed to the 50 limitation of the DAC system.

The edit routine was originally made to be as flexible as possible, allowing the user to choose from a variety of options as to how to edit each crystal. These options included having LabVIEW use internal routines to calculate the polynomial coefficients including the showing an overlaid graph of the input values and the fitted polynomial, however the routines were not robust enough to provide the necessary Watts versus Volts format used by the LDAP and DARIDLR plotting routines. A new routine to replace the internal LabVIEW routine may be added in the future. The options available for adding crystal diode coefficients are by screen or by file. The required file format is the polynomial order (two to five) on the first line, then each successive coefficient listed on a separate line (see Appendix B for how the coefficients are used by LDAP), in ASCII format.

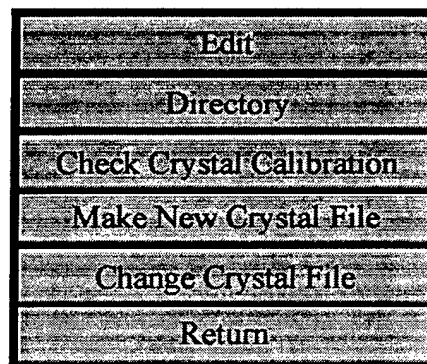


Figure 3.19. The 'Crystal Menu' options.

The screenshot shows a graphical user interface with the following elements:

- A text field at the top labeled **Title**.
- A text field below it, currently empty.
- A text field labeled **Coefficients** containing several rows of data.
- A text field labeled **PolyCoef** containing the value **0**.
- A list box labeled **Edit ListBox** containing the following options:
 - Input Coefficient Values From File
 - Input Coefficient Values From Screen
 - Edit All Coefficients of Crystal
 - Edit Single Coefficient of Crystal
 - Calculate Coefficient Values From File Input
 - Calculate Coefficient Values From Screen Input
- Two buttons at the bottom: **Select** and **Return**.

Figure 3.20. The options available to input the polynomial coefficients for the crystal diode configuration.

3.4.6.2 Directory

This routine displays the different crystal title, calibration coefficients and polynomial order, stored in the present crystal file. The displayed parameters are the crystal number (as stored in the file) and the crystal title. Double-clicking on any title will display the associated polynomial coefficients.

3.4.6.3 Check Crystal Calibration

This routine allows you to check a stored calibration. Figure 3.21 shows the displayed fields on the screen. Enter as many values as you wish in the array field on the left, and after pressing 'Check Calibration', the corresponding calculated values will be displayed in the array field on the right, using the associated polynomial coefficients.

have, all the data for a given number of shots were stored in a single directory. LDAP is not setup to handle files stored in this manner, and expects each data shot to have its own self-contained directory. This routine takes many data shots stored within one directory and creates an individual directory for each shot and moves the data for that shot into the newly created directory. The routine also creates a SHOTxxxx.TIM file (see next section).

3.4.8 Make Time Stamp

This routine was added to assist in plotting data using DARIDLR. LDAP uses the time and date information stored as part of the SHOTxxxx.CHN file (the resource format created and used by DOS, Windows, and the MacOS), but DARIDLR does not yet have this ability. Thus a time and date ASCII data file is created, called SHOTxxxx.TIM, which stores this information.

3.4.9 Return

Returns to the Utilities Menu.

3.5 Save Setup

This routine enables the user to save the present setup to a setup file, or to create a new setup file with various options (such as whether to use the same probe file or make a new one). The user is prompted to select a setup number (not equal to zero), and then the user must press the 'Make Setup File' button to create the new setup file (see Figure 3.22). Use Recall Setup to recall a newly (or previously) saved setup file.

To create a completely new setup file, use the following steps:

- 1) When LDAP initially prompts for a setup file, click cancel.
- 2) When LDAP asks for a parameters file, click 'No' (or equivalent).
- 3) When LDAP asks to create a new parameters file, click 'Yes' (or equivalent).
- 4) When LDAP prompts for a new file name, first create a new folder, then a new file name for the parameters file.
- 5) Under the Utilities Submenu, select 'Probes'; select 'Make New Probe File'; at the prompt for a new probe file name, make sure you are in the new folder that you created in step 4, and make a new probe file name. Select 'Don't Update' when asked whether or not to update the current setup.
- 6) Under the Utilities Submenu, select 'Cables'; select 'Make New Cable File'; at the prompt for a new cable file name, make sure you are in the new folder that you created in step 4, and make a new cable file name. Select 'Don't Update' when asked whether or not to update the current setup.
- 7) Under the Utilities Submenu, select 'Crystals'; select 'Make New Crystal File'; at the prompt for a new crystal file name, make sure you are in the new folder that you created in step 4, and make a new crystal file name. Select 'Don't Update' when asked whether or not to update the current setup.
- 8) Return to the Main Menu, and select Save Setup. Choose a setup number $\neq 0$. Press the 'Make Setup File' button. When prompted for new setup file name, make sure you are in the new folder created in step 4, and make a new setup file name. When prompted for all other options, select yes for creating new: 'Channel Directory' and then create it; 'Shot Directory' and then create it; choose the probe file created in

- step 5; choose the cable file created in step 6; choose the crystal file created in step 7; choose the parameters file created in step 4. Press the 'Done/Return' button to return to the main menu.
- 9) Select Recall Setup and select the newly created setup file.
 - 10) Initialize new channels; Create new probes, cables, crystals.

3.6 Recall Setup

Recall a previously stored setup file.

3.7 Change Channel Directory

This routine was placed here to be consistent with the original placement in the DAC program. The routine allows the user to change which channel directory to use as the channel configuration files. This routine automatically updates the setup file. Note that for Windows95 and MacOS users, you can create a new directory when the standard save file resource manager is called (built into LabVIEW), without first having to go to the desktop and created a new shot directory. This menu choice is also available in the 'Main Menu:Channel Menu' submenu.

3.8 Configuration

Calls up the Configuration Menu which contains the 'AutoPlot', 'Set Plot Range', 'Change Default Shot Number', 'Change Parameters File', and 'Routine To Plot' options. See Figure 3.23.

File Format is:

- 1) Setup # (Defaults to zero, but zero is not a valid setup #. This is done to force the user to manually change the number, without accidentally overwriting a previously saved setup.)
- 2) Default Channel Directory
- 3) Default Shot Directory
- 4) Last Shot Taken (Defaults to zero, or is input from present running setup, or can be manually changed by user.)
- 5) channel listing (this checks to see if there is anything in the default channel directory, and stores the file names).

SetUp Number

0

Last Shot Taken

0

Make Setup File

Done/Return

Figure 3.22. The 'Save Setup' window.

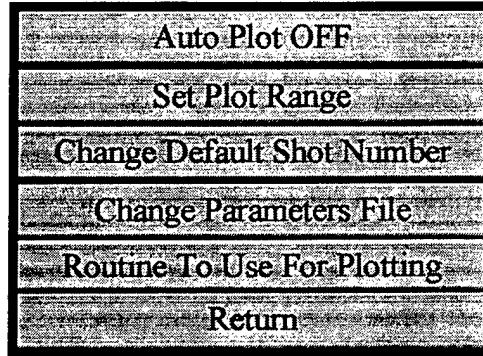


Figure 3.23. The 'Configuration Menu' options.

3.8.1 AutoPlot

A boolean button that is initially set to 'Off'. If the button is set to 'On', the 'Fire Shot' routine will automatically plot the data after having saved the acquired data to disk.

3.8.2 Set Plot Range

Allows the user to select a plot range that displays all the data shots within the chosen minimum and maximum 'x' range. However, if there are not enough data points within the plot range for a particular data channel, the program will display the whole trace for that channel data. This may occur if one of the channels was taken on a much larger time scale (such as magnetic field data, which is typically taken on a microsecond or millisecond time scale, as opposed to most RF or Pulsed Power data which may be taken on a couple of hundred nanoseconds time scale). This menu choice is also available under the 'Main Menu:Fire Shot' submenu.

3.8.3 Change Default Shot Number

This routine allows the user to change the default shot number stored in the setup file (and also displayed on screen in the 'DisplayData' Window). The default shot number can also be changed during the 'Fire Shot' sequence.

3.8.4 Change Parameters File

This routine allows the user to change the parameters file presently being used by LDAP. Note that this does *not* update the setup file, since this information is initially loaded from the directory that the setup file is stored in, not in the setup file itself. This may be changed in future versions, to include the parameters file as part of the overall setup file.

3.8.5 Routine To Plot

This enables the user to choose from a menu ring which plotting routine to use to display the saved shot data. Presently, only two options are available, LDAP and DARIDLR.

3.8.6 Return

Returns to the Main Menu.

3.9 DAR

At present, this button calls IDL. To enter DARIDLR, type *@stdalon* at the IDL prompt.

3.10 DG535 Submenu

LDAP also allows you to setup and control a Stanford Research Systems DG535 digital delay generator. Pressing this button from the Main Menu pulls up the DG535 submenu, which contains five buttons from which to choose. These buttons are 'Create A DG535 Settings File', 'Edit A DG535 Settings File', 'Send A Settings File to a DG535', 'Disable/Enable Computer Triggering', and 'Return'. See Figure 3.24.

3.10.1 Create A DG535 Settings File

Creating a setup file is relatively easy in that the routine allows you to make a setup file using one of two options. First, the routine prompts you to name the settings file. Then the routine asks you for the GPIB bus and address of the DG535. Next the user is prompted to choose whether one would like the default settings for the DG535 stored as the settings file, or if the user would like the routine to query a DG535 to obtain the settings file. The user should make sure that the settings that are to be saved are the current displayed settings on the DG535. If a setting is presently stored in one of the memory

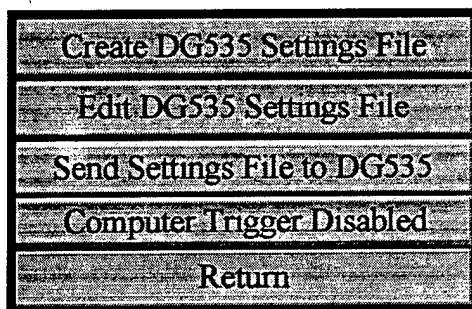


Figure 3.24. The 'DG535 Menu' options.

locations of the DG535, the user can recall them from either the front panel of the DG535, or may use the 'Recall' button from the 'Edit A DG535 Settings File' submenu (discussed below). If the user selects the 'Get the settings from the DG535, the routine will then have the DG535 display the message 'Sending Settings', and will query the DG535 for the current settings. This takes about thirty seconds, so be patient. The settings, along with the GPIB information, are then stored in a file in the format listed in Appendix B.

3.10.2 Edit A DG535 Settings File

The 'Edit A DG535 Settings File' button pulls up a submenu that gives you a choice of the following buttons: 'Delay', 'Trigger', 'Output', 'GPIB', 'Store', 'Recall', and 'Return' (see Figure 3.25). Delay allows you to set the delays of the four channels of the DG535 ('A', 'B', 'C', and 'D'). See Figure 3.26 for an example of the layout. Note there is no option to set the delay referenced to the channel itself. But also note that at the present time there is no error checking to prevent the setting of 'A = B \pm <value>' and then 'B = A \pm <value>'. This will cause the DG535 to give an error, and stop processing commands. Error checking will probably be added in a future version.

The 'Trigger' button allows you to set all the trigger settings (Internal, External, Single Shot, Burst, and Line) by use of a simple slide control (see Figure 3.27). You may set each individually, but note that the routine stores ALL the settings (and thus sends all the settings when you use the 'Send Settings File to a DG535'). Note that all the fields are not displayed at once; only those that are necessary according to the current selection of the slide bar are displayed. For example, if the slide is set to 'External', only the 'Threshold', 'Slope', and 'Trig Termin' fields are displayed.

Similarly, the 'Output' button allows you to set all the output parameters (use the menu ring control to select which output to update). See Figure 3.28 for an example of the 'Output' window layout. Note that not all fields are displayed at once; fields are only displayed as necessary. For example, if you choose 'TTL' as the 'Mode', the 'Polarity' and 'Amplitude' fields are not displayed.

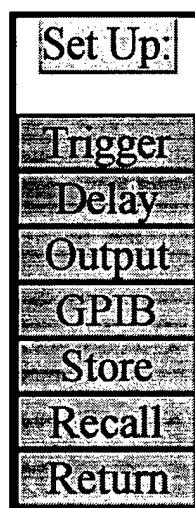


Figure 3.25. The 'Edit A DG535 Settings File Menu' options.

Set the Delays

A =	T0	Minus	0.000000000000
B =	T0	Minus	0.000000000000
C =	T0	Minus	0.000000000000
D =	T0	Minus	0.000000000000

Return

Figure 3.26. Example of the 'Delays' window.

☐ Internal
 ☐ External
 ☒ Single Shot
 ☐ Burst
 ☐ Line

Int Rate (Hz)	Burst Rate (Hz)	Pulses/Burst	Periods/Burst
10.000	10.000	2	2

Threshold	Slope	Trig Termin
0.00	Negative	50 Ohm

Return

Figure 3.27. Example of the 'Triggers' window. Note that all the fields are not displayed at once; only those that are necessary according to the current selection of the slide bar are displayed. For example, if the slide is set to 'External', only the 'Threshold', 'Slope', and 'Trig Termin' fields are displayed.

Output Port	Load	Mode	Polarity	Amplitude
T0	50 Ohm	TTL	Inverted	0.00
Return				

Figure 3.28. Example of the 'Outputs' layout. Note that not all fields are displayed at once; fields are only displayed as necessary. For example, if you choose 'TTL' as the 'Mode', the 'Polarity' and 'Amplitude' fields are not displayed.

The GPIB button allows you to set the GPIB bus and address of the DG535 (the routine does not set the DG535 GPIB bus and address remotely; use the DG535 front panel). The values are set by typing in the number, or by clicking the up/down arrows (see Figure 3.29).

3.10.3 Send Settings File To A DG535

The 'Send Settings File to a DG535' prompts the user for a DG535 settings file (the routine will only list those files of the correctly stored format; see Appendix B), and will send the settings to the DG535. This takes approximately five seconds.

3.10.4 Store and Recall Settings On A DG535

The 'Store' and 'Recall' buttons interact remotely with the DG535, enabling the user to store the current settings of the DG535 in the internal memory of the DG535, or to recall a previously stroed setting within the DG535 memory. Note that the recall setting defaults to one as the recall location. This was done to avoid inadvertent resetting of the DG535 default parameters, wich are stored in location zero.

Set The GPIB Bus and Address	
GPIB BUS#	0
GPIB ADDRESS	0
Return	

Figure 3.29. Example of the 'GPIB' window.

3.10.5 Disable/Enable Computer Single Shot Trigger

The 'Disable/Enable Computer Single Shot Trigger' allows the user to send the DG535 a 'Single Shot' command (as if you pressed the (EXC) button on the DG535 while in the Single Shot mode). If enabled, the user is prompted for the GPIB bus and address of the target DG535, and a 'Send a Trigger to the DG535' button is enabled on the 'Waiting For Trigger' module (described in the 'Fire Shot' section, §3.2.1). The current status of this button is displayed in the 'DisplayData' window.

3.10.6 Return

Return takes you back to the Main Menu.

3.11 General Info

This displays the current version of LDAP being used, when it was last modified, and contact information of the author.

3.12 Exit

This exits LDAP, but does not close 'BeginWithMe.vi' nor quit LabVIEW, to allow the user to restart LDAP without re-loading from scratch all the associated LDAP modules.

4. How LDAP Plots Data

LDAP (as well as DARIDLR) plots data in a systematic way. It takes the raw data (the numerical Byte or Word data obtained from each digitizer) stored in the data file, and then converts it to what was displayed on the given digitizer (by using the corresponding header information obtained from the digitizer and also stored with the raw data), then taking into account any attenuations stored in the data file, any probe information, and adjusts the time scale according to the stored cable delay information. At present, LDAP (or DARIDLR) does not take into account any different sweep delays between different digitizers (always starting from the zero/trigger point stored as part of the header information). This may be added in a future version, if warranted. If there is a integrator used, and its value is set to a non-zero number, then LDAP (and DARIDLR) automatically corrects for any 'droop' that may be associated with a finite timescale passive integrator. LDAP does this by first taking the derivative of the 'raw signal', and then numerically integrating the new derivative signal. This is based on the circuit shown in Figure 3.30.

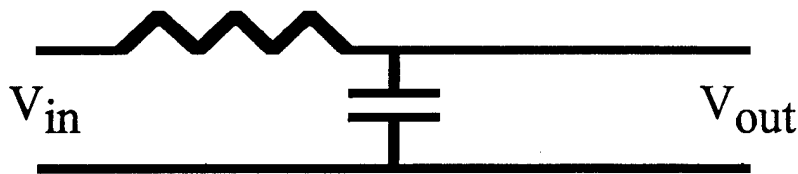


Figure 3.30. Simple circuit model of the passive integrator.

If τ is the RC time constant of the passive integrator, then

$$V_{in} = \tau * \dot{V}_{out} + V_{out}$$

V_{out} is the measured value (acquired from the digitizer). By solving for V_{in} in the above equation, and then numerically integrating V_{in} , any signal droop caused by the passive integrator's finite time constant is removed.

If a crystal diode calibration is used, then the data is converted according to the stored polynomial coefficients, and the y-axis label is set to 'Watts'.

5. Features Planned For Future Versions

Some of the features that may be added to future versions (depending on time, demand, etc.) are listed here, not in any particular order, mostly for the author's reference.

- 1) Show titles for channel directory and edit listings.
- 2) Add associated titles and date/time fields to cable file.
- 3) Add button to assist converting ASYST/DAC setup files to LDAP setup files.
- 4) Add Menus to assist converting ASYST/DAC Cable, Probe, and Crystal Files to LDAP format.
- 5) Add Menu to assist in converting ASYST/DAC stored data files to LDAP Format.
- 6) If not 5), then update 'Edit Shot' routine to handle ASYST/DAC formats.
- 7) Allow the LDAP plotting routine to be cancelled midstream.
- 8) Make routine to allow double-clicking of cable/probe/crystal listing to automatically update the 'Configure Channel' probe/cable/crystal associated number.
- 9) Add error checking routines where necessary.
- 10) Add other digitizers as necessary
- 11) Add choice of record length to 'Configure Channel' routine for digitizers that allow this option (this will likely change the channel description file formats; because of this, a routine to automatically update old channel description files may have to be added also!).

Appendix A. The Requisite Quick Menu Reference

This Appendix gives a quick reference of all the Menu and Submenu items available in LDAP, and a brief description. For more details about a given item, see the main sections of this manual.

Main Menu - The Main Menu of LDAP

Shot Menu - Opens the window containing the Shot Menu Items.

Fire Shot - Programs digitizers, allows shot number and parameters changes, retrieves digitizer data, saves the data to disk, and automatically plots the data if 'AutoPlot' is set to On.

Directory - Shows the contents of the setup's current shot directory

Change Shot Directory - Changes the shot directory, and updates the setup file to reflect this change.

Plot Shot - Plot a shot, either the previous or any other of LDAP (LabVIEW) or DAC (ASYST) format. Calls DARIDLR if the 'Routine to Plot' is set to IDL.

Set Plot Range - Sets the minimum and maximum 'x' range values to be used when plotting (used by both LDAP (LabVIEW) and DARIDLR (IDL) plotting routines).

Edit Parameters - Edit the current associated shot parameters.

View Parameters - View the current associated shot parameters.

Program Channels - Programs the digitizer channels.

Edit Shot - Change a limited number of information, such as the probe, crystal, etc., from a previously taken shot.

Utility - A relic from the past, does nothing at present. Many of the DAC utilities are available from DARIDLR.

Shot Delay - Again, a relic from the past, does nothing at present. Use Configure Channel to set the delays.

Return - Return to Main Menu.

Channel Menu - Opens the window containing the Channel Menu Items.

Configure Channel - Configure any channel in the setup's current channel directory.

Channel Directory - Displays the channels in the setup's current channel directory.

Initialize - Initialize a new channel. The new channel is saved in the current channel directory, and the setup file is updated to reflect the addition of the new channel.

Turn On/Off - Turn on or off a selection of channels. Displays the current on/off status of all the channels in the current channel directory.

Show Hookup - Displays the current status of all the channels that are 'On' (such as what probe number, cable number, title, etc.)

Program Channels - Programs the digitizer channels.

HP54 Colors - Another 'oldie but a goodie', but not used here.

Return - Return to Main Menu.

Utilities Menu - Opens the window containing the Utilities Menu Items.

HP54111D Prg - Another 'oldie but a goodie', but not used here.

Change Channel Directory - Change the current channel directory. Updates the setup file to reflect this change.

Change Shot Directory - Change the current shot directory. Updates the setup file to reflect this change.

Probes - Opens the window containing the Probe Menu Items.

Edit - Edit a previously created probe, or create a new probe. Updates the current probe file.

Directory - Displays the current list of probes stored in the probe file.

Make New Probe File - Make a new probe file.

Change Probe File - Change the current probe file to another. This does NOT update the setup file, so be careful using this function.

Return - Return to the Utilities Menu.

Cables - Opens the window containing the Cable Menu Items.

Edit - Edit a previously created cable, or create a new cable. Updates the current cable file.

Directory - Displays the current list of cables stored in the cable file.

Make New Cable File - Make a new cable file.

Change Cable File - Change the current cable file to another. This does NOT update the setup file, so be careful using this function.

Return - Return to the Utilities Menu.

Crystals - Opens the window containing the Crystal Menu Items.

Edit - Edit a previously created crystal, or create a new crystal. Updates the current crystal file.

Directory - Displays the current list of crystals stored in the cable file. Double clicking on any listed crystal title displays the crystal's coefficients.

Check Crystal Cal - Check the crystal calibration by inputting any number of values and examining the output.

Make New Crystal File - Make a new crystal file.

Change Crystal File - Change the current cable file to another. This does NOT update the setup file, so be careful using this function.

Return - Return to the Utilities Menu.

Make Single Shot Directories - Takes a shot directory which contains several different stored data shots, and creates a separate shot directory for each individual shot. Automatically creates a time/date file.

Make Time Stamp - Create a time/date file for a given shot directory (generated from the date/time info of the *.CHN file in the shot directory).

Return - Return to Main Menu.

Save Setup - Save and/or create a new setup file.

Recall Setup - Recall a previously created setup file.

Change Channel Directory - Change the current channel directory. Updates the setup file to reflect this change.

Configuration - Opens the window containing the Configuration Menu Items.

AutoPlot - Toggles the AutoPlot constant to On or Off. Default is Off.

Set Plot Range - Sets the minimum and maximum 'x' range values to be used when plotting (used by both LDAP (LabVIEW) and DARIDLR (IDL) plotting routines).

Change Default Shot Number - Change the default shot number of the current setup. Updates the setup file to reflect the change.

Change Parameters File - Change the current parameters file to another. This does NOT update the setup file, so be careful using this function.

Routine to Plot - Choose which program to use to plot the data, from a menu ring.

Return - Return to Main Menu.

DAR - Calls IDL. To enter DARIDL, type *@stdalon* at the IDL prompt.

DG535 Menu - Opens the window containing the Channel Menu Items.

Create File - Create a DG535 setup file.

Edit File - Edit a previously created DG535 setup file.

Send File to DG535 - Send a setup file to the DG535.

Disable/Enable Computer Triggering - Enables/Disables the ability to send a single shot trigger command to a DG535.

Return - Return to Main Menu.

General Info - Displays general info about the LDAP program, including the last modification date.

Exit - Exits LDAP. Does NOT exit LabVIEW, nor the 'BeginWithMe.vi.'

APPENDIX B. File Formats

In the listings below, LabVIEW binary format is the default format used by LabVIEW to store its data files. The reader should refer to Reference 2 for a more detailed explanation. LDAP expects the following formats for the files it uses.

B.1 Setup File

LabVIEW binary format. The file may have any extension. The file contains (in order):

Description	Data Type
Setup Number	I16
Present Channel Directory	Path
Present Shot Directory	Path
Default Shot Number	I32
Channel File Listings	Array of Strings

B.2 Parameters File

LabVIEW binary format. The file may have any extension, but when stored by LDAP as part of the saved shot data, the file has the extension '.PRM'. The file contains an array of strings.

B.3 Cable File

LabVIEW binary format. The file may have any extension. The file contains the one-way time delays of the data cables, stored as an array of double precision real numbers.

B.4 Crystal File

LabVIEW binary format. The file may have any extension. The file contains six coefficients of up to a fifth order polynomial equation that describes the calibration curve for the crystal diode detector. If a lesser order polynomial fit is used, the upper coefficients are set to zero. The coefficients are listed as follows:

$$Y = a_0 + a_1X + a_2X^2 + a_3X^3 + a_4X^4 + a_5X^5$$

where Y is in watts, and X is in volts. The coefficients are stored as a string of the form:

$a_0 = 3.4441e-6$; $a_1 = 3.4441e-6$; $a_2 = 3.4441e-6$; $a_3 = 3.4441e-6$; $a_4 = 3.4441e-6$;
 $a_5 = 3.4441e-6$;

The file contains (in order):

Description	Data Type
Coefficients ($a_0 - a_5$)	Array of Strings
Title of Crystal Diode	Array of Strings
Order of Polynomial Fit (2-5)	Array of I32

B.6 Probe File

LabVIEW binary format. The file may have any extension. The file contains the title of the probe calibration, the unit of the probe calibration (used as the y-axis label on subsequent plots), and the probe calibration value. Stored in the file are (in order):

Description	Data Type
Title of Probe Calibration	Array of Strings
Unit of the Probe Calibration	Array of Strings
Value of Probe Calibration	Array of DBL

B.7 SHOTxxxx.CHN File

LabVIEW binary format. Contains the following:

Description	Data Type
Shot Number	I16
Number of Channels	I32
Channel Titles	Array of Strings
Channel File Names	Array of Strings
Cluster of 3 Elements:	
1) Cluster Probe Information (3 Elements):	
1.1) Titles	Array of Strings
1.2) Units	Array of Strings
1.3) Values	Array of DBL
2) Cable Information:	Array of DBL
3) Cluster of Crystal Information (3 Elements):	
3.1) Polynomial Coefficients	Array of Strings
3.2) Titles	Array of Strings
3.3) Polynomial Order	Array of I32

B.8 Channel Description Files

LabVIEW binary format. The extension is the same as the setup number stored in the setup file. For example, 'CH100.2' would be the description of channel 100 in setup number 2. Probe number, cable number, and crystal number correspond to the information stored in the Probe file, Cable file, and Crystal file. The file is laid out as follows (in order):

Description	Data Type
Scope Type	I8
On/Off Status (True/False)	Boolean
Title	String
GPIB Address	I16
GPIB BUS	I16
Scope Channel #	I16
Fixed Attenuation	DBL
Cable Attenuation	DBL
Other Attenuation	DBL
Integrator Value	DBL
Probe Position Description	String
Probe #	I16
Cable #	I16
Crystal #	I16
Comments	String
Volts/div	DBL
Offset	DBL
Coupling (DC 1M, DC50, AC, GND)	U16
V/div units (mV, V)	U16
Data Increment (Not Used)	U16
Attenuation Constant (Not Used)	String
Trigger Voltage Level	DBL
Slope (+ = True, - = False)	Boolean
Trigger Mode (Edge, Pattern, ???)	U16
Trigger Source (External, Channel 1-8, External 3-4)	U16
Sweep Range	DBL
Sweep Range Units (ps,ns,μs,ms,s)	U16
Sweep Delay	DBL
Timebase Mode (Auto = True, Triggered = False)	Boolean
Sweep Delay Units (ps,ns,μs,ms,s)	U16

The scope type contains a byte formatted number corresponding to the following table:

Type of Scope	Value
HP54111D	0
HP16531A (400 MSa in 16500)	1
HP16532A (1 GSa in 16500)	2
TEK TDS544A	3
TEK DSA602A (Not Implemented)	4
TEK TDS720 (Not Implemented)	5
TEK 2440 (Not Implemented)	6

B.9 Stored Channel Raw Data Files

LabVIEW binary format. Contains the channel header information; rawdata; shot number; a cluster of the following: a cluster of scope/atten/probe/cable/crystal information, cluster of probe information, cable information, and a cluster of crystal information, in the following format:

Description	Data Type
Channel Header	10 Element Array of Strings
Raw Data	Variable Length Array of I16
Shot Number	I16
Cluster 4 Elements:	
1) Cluster of 11 Elements:	
1.1) Scope Type	I8
1.2) Title	String
1.3) Fixed Attenuation	DBL
1.4) Cable Attenuation	DBL
1.5) Other Attenuation	DBL
1.6) Integrator Value	DBL
1.7) Probe Position Description	String
1.8) Probe #	I16
1.9) Cable #	I16
1.10) Crystal #	I16
1.11) Comments	String
2) Cluster of Probe Information (3 Elements):	
2.1) Title	String
2.2) Unit	String
2.3) Value	DBL
3) Cable One-Way Delay	DBL
4) Cluster of Crystal Information (3 Elements)	
4.1) Polynomial Coefficients	String
4.2) Title	String
4.3) Polynomial Order	I16

The channel header string array has stored as elements: (HP nomenclature)

- 5) XINC as DBL
- 6) XORG as DBL
- 7) XREF as I32
- 8) YINC as DBL
- 9) XORG as DBL
- 10) YREF as I32

The raw data variable length array is at present either 4096 (only for the HP16531 400 MSa digitizing Card), or 8192 for all other scopes. The TEK TDS 544A allows variable record lengths, but at present is always set at 5000, and the rest of the 8192 array length is padded with the value found at element 4999. The HP16532 1GSa digitizing card only allows 8000 points (neglecting the fact that you could have less if you only transferred the displayed window data), and thus is also padded to 8192. Future versions of LDAP will probably be more flexible.

B.10 SHOTxxxx.DAT

LabVIEW binary format. Contains a record of a cluster of four elements for each individual channel used for that particular shot. The first element is a cluster which contains the thirty elements corresponding to the channel description file. The second element contains a cluster of three elements corresponding to the probe information. The third element contains the cable one-way delay information. The fourth element contains a cluster of three elements corresponding to the crystal information.

B.11 SHOTxxxx.TIM

ASCII Format. Single line containing the date and time of when the shot was recorded. LDAP reads this as a string.

B.12 FILEDIR.DAT

ASCII format laid out as follows:

- 1st Line: Full Shot Directroy Path
- 2nd Line Number of acquired data files in the directory ('n')
- 3rd - n+2 lines: file names of the data files

B.13 DATARANG.DAT

ASCII format. The first line contains the minimum timebase value to plot. The second line contains the maximum timebase value to plot.

B.14 DG535 Settings File

LabVIEW binary format. Contains four separate elements.

The first element contains information on the Delay Format. This element is a four element array of clusters. The first cluster contains information on 'A', the second on 'B', the third on 'C', and the fourth on 'D', where 'A', 'B', 'C', and 'D' are the output channels. These clusters contain 3 elements: 1) Relative To: U16; 2) Plus/Minus: Boolean (F= Plus); 3) Delay Value: DBL.

The second element contains information on the trigger. This contains:

Description	Data Type
Trigger Type (TM 0-4)	I8
Internal Rate	DBL
Burst Rate	DBL
Period/Burst	I32
Pulses/Burst	I32
Trigger Termination (F = 50 Ohm)	Boolean
Slope (F = Negative)	Boolean

The third element contains information on the channel output. This contains:

Description	Data Type
Load (Zero = 50 Ohm)	Array of I8
Mode (0=TTL)	Array of U16
Polarity (Zero = Inverted)	Array of I8
Amplitude	Array of DBL
Offset	Array of DBL

The fourth element contains the GPIB cluster, where the first element is the Address (I16), and the second is the Bus (I16).

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